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President's Notes

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*Inevitably, the constants in war will remain just that, constants; the fog of war will still exist. But with a new mental model, one appropriate to warfare in the information age, we will be able to make better decisions. . . .**

President's Notes

In arriving at a force posture appropriate to the nation's twenty-first-century national security requirements, the chief of any service is confronted by four questions: How to size the force? How to shape the force? How to operate the

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Vice Admiral Cebrowski has commanded Fighter Squadron 41 and Carrier Air Wing Eight, both embarked in USS *Nimitz* (CVN 68). He later commanded the assault ship USS *Guam* (LPH 9) and, during Operation DESERT STORM, the aircraft carrier USS *Midway* (CV 41). Following promotion to flag rank he became Commander, Carrier Group Six, and Commander, USS *America* Battle Group. In addition to combat deployments to Vietnam and the Persian Gulf, he has deployed in support of United Nations operations in Iraq, Somalia, and Bosnia and has served with the U.S. Air Force, the staff of Commander in Chief, Atlantic Fleet, the staff of the Chief of Naval Operations on four occasions, with the Joint Staff (as J6), and as Director, Navy Space, Information Warfare, and Command and Control (N6). Vice Admiral Cebrowski became the forty-seventh President of the Naval War College in July 1998.

force? How to change the force? The simplicity of these questions belies their enormous complexity. Even the first-order answers require an understanding of the rule set by which such judgments would be made.

Because the Navy has very long capital/time-constants, leadership must make these judgments based on enduring constants and long-period trends. Leadership must avoid the lure of highly visible shifts that are the results of a dynamic information age but that are, in essence, ephemeral. Yet, the information age is characterized by discontinuities in the very framework of long-term decision making. A new mental model for warfare is required, from the policy level through the tactical level.

The industrial mode of warfare focuses, more than anywhere else, on the physical domain. This is the domain of mass and volume. It yields a mental model based on size of force and volume of fire; it starts with inputs rather than desired effects. Access and speed, on the other hand, characterize the information age. This new model starts with the desired effects and works backward to requirements. Unlike the industrial-age model, the emerging information-age model lies in the realm of belief and reason. Warfighters have always known that battles are won and lost in the minds of the participants. Yet it was not until the information age that tools became available to address reason and belief directly. While the physical domain is only loosely coupled to outcome, the domain of reason and belief is more directly linked to it. Therefore, the new information-age model of warfare cannot be the linear descendant of traditional models, no matter how highly refined.

Models today revolve around discretely quantifiable terms, such as force ratios, probabilities of kill, and loss-exchange ratios. These terms are the working jargon of deterministic systems, by which inputs directly produce certain outcomes in warfare, without variance. We call these systems *Lanchestrian models*, after the early-twentieth-century inventor and military philosopher Frederick W. Lanchester. The models have many rules for the proper representation of forces, but their overriding goal is to predict whether we can physically defeat the opposition. In the final analysis, no model of this type is anything more than an attritional measuring stick. Yet we know from direct observation that war is far more than attrition. Sun Tzu, Clausewitz, and Mahan all tell us this, and we rigorously teach it to our students at the Naval War College; when we walk across the street for war gaming, however, we leave the lesson behind.

There are practical reasons why attritional models are still used: their inputs are easily measured, their model "runs" are easily reproduced, and their MOEs are readily understood. Simplicity wins out over complexity. The chaos of war appears to be so far beyond measuring in any reasonable manner that we consider it best to ignore (or explain away) such influences as leadership, morale, cohesion, information quality, and command and control. This is what expands

the gap between models and reality. Let us go back to Newton for a glimpse of the direction in which we must go if our models are to be truly useful.

Newton's Third Law states for every action there is an opposite and equal reaction—that is, there is feedback. When a force meets another force, each affects the other; the meeting is never one-sided. Models must also account for feedback, the reaction of the total system to any change. When we design our warfare concepts, we cannot ignore the nonlinear effects we see in actual warfare. Our attritional models fail to represent the world as we see it, so they must change. We must make new models and find new MOEs with which to evaluate them. We must change our mental model.

Network-centric warfare is such a change. Network-centric warfare looks at war as a complex, adaptive system wherein nonlinear variables continuously interact. Physical forces play a part, but so do cognitive and behavioral factors. Within the constant dimensions of war (force, space, and time), the domains of belief, knowledge, and the physical world must be portrayed. Lanchestrian models emphasize the physical, but warriors since Sun Tzu have known intuitively the importance of belief and reason to victory in war. Network-centric warfare captures these aspects, by using a systems-based approach having war en toto as its object. Therefore, any model we use to evaluate network-centric warfare must also look at all aspects of war.

From the world of science we can gather another example, one that, maybe not surprisingly, represents the complexity of warfare—*entropy*. The seeming randomness of warfare is really the interaction of many influences. For example, the rational dimension of warfare (which includes the awareness, analysis, and decision-making capability of commanders) affects each of the other dimensions as an external force at the same time that it is itself affected by such internal factors as communications, information systems, and intelligence. Every dimension thus affects all the others and is also influenced by its own internal components. Thus the whole "system" of war operates as a sum total of the integrated, contributing factors. This describes an entropic system.

Entropy, though, is not uncertainty. Entropy acknowledges that at any given time I may be unable to determine the precise value of a variable, but it declares that over time I will be able to develop a model of the system as a whole and use it to predict outcomes. The value of such a model is that it includes all factors, not just the easily quantifiable inputs. This is not a new idea but an acknowledgement that we can no longer ignore what is not easy to measure. For example, the great military historian J. F. C. Fuller, in a 1917 lecture on the basic principles of war, laid down three integrated spheres—mental (reason), moral, and physical. He soon decided, however, that the mental and moral aspects were too difficult to measure, and he accordingly directed his efforts to the physical sphere almost exclusively.

Certain new inclusive models need MOEs that precisely define the desired performance. The best way to start is to examine the interrelationships between the different influences, or domains, in war. Here network-centric warfare shows its true worth, in that its fundamental premise is *interconnectivity*. No component—physical, behavioral, or organizational—exists by itself. Network-centric warfare realizes this and seeks to address the total concept of warfare, not just attack it piece by piece. Old MOEs based on deterministic, attritional warfare miss the mark; they cannot begin to measure such aggregate warfare concepts as network-centric warfare.

New MOEs must step beyond the old ones and grasp matters to which the latter only pointed. An attritional model, for instance, would extrapolate that a given reduction in the opponent's forces would produce corresponding reductions in other attributes, such as morale. This was proven false repeatedly, but the MOEs did not change, and the extrapolations continued. New MOEs, however, must directly address the *effect*. For example, "situational awareness" is an MOE for the dimension of reason in warfare. Within situational awareness are such key metrics as information integrity, information timeliness, and ISR (intelligence, surveillance, and reconnaissance) coverage. Inherently integrated with situational awareness is command, control, and communications, which also has subsystems; and so on. Thus the MOE of situational awareness is the sum of many subcomponents, each receiving its own influences from other parts of the system. This is a comprehensive method of looking at a complex system, war, for the purpose of understanding how the entire system operates. This is a paradigm shift.

There are many other aspects of network-centric warfare that help us address the imponderable in warfare. Inevitably, the constants in warfare will remain just that, constants; the fog of war will still exist. But with a new mental model, one appropriate to warfare in the information age, we will be able to make better decisions on the size, shape, and operations of the force. Further, we will have the logic on which to base decisions in an age characterized by change.

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*The concepts addressed here were adapted from Mark Herman, *Measuring the Effects of Network-Centric Warfare*, vol. 1, technical report prepared for the Director of Net Assessment, Office of the Secretary of Defense (McLean, Va: Booz · Allen & Hamilton, 28 April 1999).